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PROCESS OF FREQUENCY CONVERSION

(Verfahren zur Frequenzumsetzung)

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A procedure for conversion of frequency has been described, using which a periodic input signal is converted into an output signal of a frequency lower compared to that of the input signal. This is done by under-sampling the input signal with the help of a sampling signal. The frequency of the sampling signal is specified by means of a digital direct synthesiser, which is adjusted to a frequency that is proportional to that of the input signal, the time signal being derived from the input signal. /1[1]

Description

The invention concerns a procedure stated in the title of the first claim of the patent. Such a procedure has been described on pages 55 - 57 in the literature titled "Measuring techniques" authored by Stadler and Hartmannsgruber and published by Senn, Tettnang in 1985.
In this procedure, a rapidly increasing saw tooth voltage having the same frequency as that of the input signal is compared with a slowly increasing saw toothed voltage. The result of the comparison produces a sampling signal. Each time the rapidly increasing saw tooth voltage attains a value equal to that of the slowly increasing saw toothed voltage, this sampling signal shows a narrow sampling impulse. The input

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[1]Numbers in the margin indicate pagination in the foreign text.

signal is scanned with the help of this sampling signal. Here it is a case of under-sampling the signal because the frequency of the sampling signal is less than twice that of the input signal.

The major disadvantage of such a procedure is felt when there is a kickback in the progressing saw toothed voltage. Based on this kickback in the voltage, the output signal produced by the sampling is put together by several lines of curves in a row. However, two neighboring curves are displaced opposite to each other, that is the output signal indicates a shift in the phase at the terminal points of the adjacent curves, such that it corresponds to an input signal showing waves with longer time intervals.

As has been mentioned in the title of the first claim of the patent, the invention aims at determining the procedure of producing an output signal without showing any shifts in phase.

According to the description of the invention, the problem is solved by the characteristic features of the first claim of the patent. The sub claims may result in further designs and developments. The invention is based on the understanding that sampling signal can be produced consistently and without any time lag by means of a digital direct - synthesiser. The synthesiser is clocked in pulses by the timing signal that is derived from the input signal, the frequency of the sampling signal being proportional to that of the input signal. The

frequency of the sampling signal is specified by the digital direct - synthesiser and is at the same time, dependent on the frequency of the sampling signal because it is the sampling signal that clocks the direct - synthesiser in pulses.

The direct - synthesiser is programmed in such a manner that it operates as a frequency divider with a non-integer division factor. As a result, the frequency of the timing signal is higher than that of the sampling signal and neither is it the harmonic frequency of the sampling signal.

In a more popular design of the procedure, the direct - synthesiser first generates an oscillator signal from which the sampling signal is produced by the pulse wave former.

The procedure described in the invention has several advantages, which may be summarized as under:

- It is used particularly for measuring high frequency input signals accurately since a suitably programmed direct - synthesiser enables adjustment of the frequency of the output signal to a value that lies in the permissible range of measurement for the measuring device used. Measurement of the input signal is then reduced to measurement of the output signal.
- It is also used for the spectroscopic analysis of the input signal because the output signal does not show any jumps in the phase caused because of the sampling. As a result, the frequency spectrum of the output signal

corresponds to the frequency spectrum of the input signal.

- It is particularly suitable for measurement of the input signals disturbed by frequency modulation or by phase jitters, because in case of frequency modulated input signals, the interval of the output signal may vary depending on the direct - synthesiser operating as a frequency divider. This variation in the interval may be such that the values of the input signal sampled in the case of frequency - modulated input signals and those sampled in the case of unmodulated that is undisturbed input signals may be the same.

With reference to the figure, the following is a detailed description of the invention. The figure serves as an example of the design of the circuit.

According to the figure, the input signal U_E is supplied to the input E of a power divider LT and to the sample-holder AH via the power divider LT. The input signal U_E is also supplied to the time extraction unit TA. The time extraction unit TA produces the timing signal U_T from the input signal U_E by amplification and pulse shaping. The timing signal U_T is fed to the time input TE of the digital direct - synthesiser DS and is the default time base of the digital direct - synthesiser DS. In case the frequency f_E of the input signal U_E exceeds the maximum permissible clock frequency of the digital direct -

synthesiser DS, the frequency f_E of the input signal U_E can be divided in the time extraction unit TA by an integral factor N_1. The digital direct - synthesiser DS produces the oscillator signal U_O from the timing signal U_T. The frequency f_O of this oscillator signal U_O is lower than the frequency f_T of the timing signal U_T. The progression of graph of the oscillator signal U_O is specified by a range of data elements, which are read out from the memory by the digital direct - synthesiser DS and / or calculated according to a specific algorithm. The data elements are generated in succession as per the time interval specified by the frequency f_T of the timing signal U_T and these elements represent the value of the oscillator signal U_O shown at the time the data element is generated. An transition of the series of data elements from analog to digital and if necessary, followed by a smoothing of the signals generated by the transition from analog to digital gives the desired progression of graph of the oscillator signal U_O. The digital direct - synthesiser DS operates as a frequency divider with a non-integer division factor of the frequency f_T of the timing signal U_T to the frequency f_O of the oscillator signal U_O. The oscillator signal U_O is fed to the pulse wave former IF, which then produces a sampling signal U_A having the same frequency as the oscillator signal U_O. As a result, the ratio of the frequency f_A of the sampling signal U_A to the frequency f_E of the input signal U_E is a non-integral factor greater than 1. The sampling signal U_A shows a large

number of sampling pulses with widths that are clearly smaller, that is to say, practically ten times smaller than the interval of the input signal U_E. Every sampling pulse is separated from the neighboring sampling pulses by a time interval of f_A^{-1} of the sampling signal U_A. The input signal U_E is sampled in the sample - holder AH, which is driven by the sampling signal U_A intermittently at times specified by the sampling pulses of the sampling signal U_A. The sample-holder AH then gives the resulting output signal U_M. The frequency/3 of the output signal f_M is lower than the frequency f_E of the input signal U_E and the progression of the wave in terms of time, corresponds to the input signal U_E showing waves with longer time intervals. Hence, the input signal U_E can be measured by measuring the output signal U_M with the help of the sample -holder AH and the other downstream equipment. In addition, a low pass filter TP for smoothing the output signal U_M may be connected between the sample - holder AH and the measuring devices.

Patent Claims

1. The procedure for conversion of frequency in which a periodic input signal (U_E) is converted into an output signal (U_M) of a frequency lower than that of the input signal (U_E) by under-sampling the input signal (U_E) with the help of a sampling signal (U_A) is characterized by the fact that frequency f_A of the sampling signal U_A is

specified by the digital direct - synthesiser DS, which is clocked in pulses by the timing signal (U_T) that is derived from the input signal (U_E), the frequency of the timing signal (f_T) being proportional to the frequency (f_E) of the input signal (U_E).

2. Procedure described in claim 1 is characterized by the fact that the direct synthesiser (DS) is programmed in such a manner that it operates as a frequency divider with a non-integer division factor.

3. The procedure as per claims 1 or 2 is characterized by the fact that the direct synthesiser (DS) generates an oscillator signal (U_0) from which the sampling signal (U_A) is produced by the pulse wave former (IF).

4. The procedure as per one of the claims above, is characterized by the fact that the procedure described can be used for measurement of high frequency input signals (U_E).

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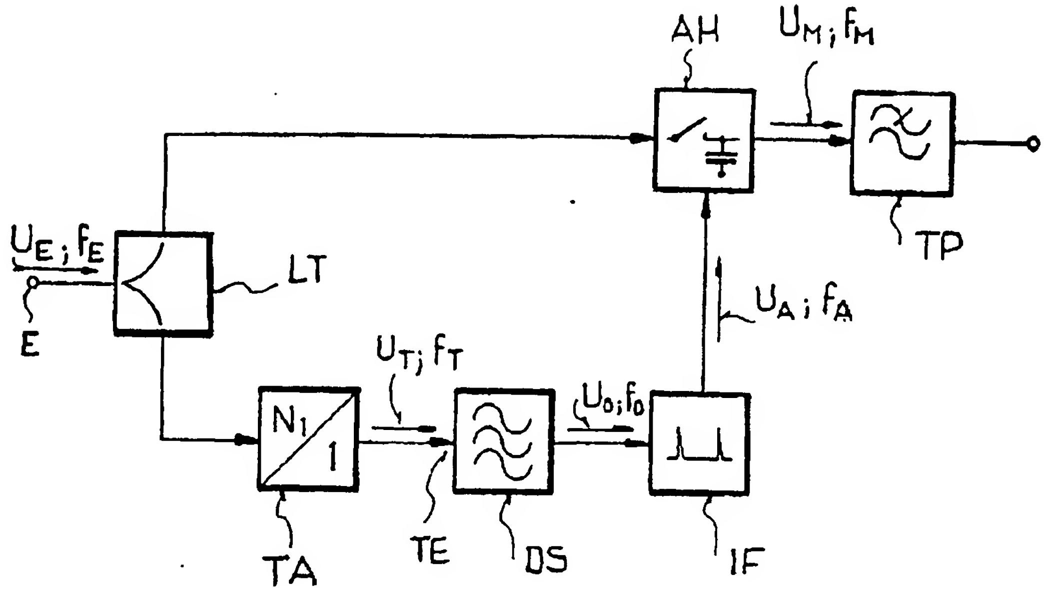

FIG.